The World's Largest Experimental Flying Station

By BRICE O. REAY, '30

It has been mainly through the courtesy of Captain E. M. George, Construction Quartermaster at the new Wright Field, that the compilation of this technical data has been made possible.

ONE of the latest and one of the most important of great engineering achievements sponsored by the United States Government is the development of the new Wright Aviation Field. The Field is located in the heart of one of the richest industrial centers of Ohio. Three miles east of Dayton lies a level tract of land covering 5,000 acres, which has been contributed by the citizens of Dayton to the U. S. Government to be used for Aviation experimental purposes. In making use of this gift, the U. S. Army Air Corps has decided to establish a large experimental station on this territory.

Less than a year ago actual construction was started on the field. At that time the funds available for use were not large but by January 1, 1927, approximately one and one-half million dollars were under contract. It has been estimated that it will take about five years to complete the construction on the field if the necessary appropriations are made by Congress as they are needed.

The important features of the Field now under construction are the Administration Building, the Testing Laboratory, the Warehouses, the Assembly Shops, and the Wind Tunnel Unit. Mr. E. H. Latham of Columbus, a former graduate of the Ohio State University, has the contracts for constructing the Administration Building and the Assembly Shops. The Testing Laboratory and the Generator Power House are being constructed by the Dannis-Hunt Company of Dayon. The largest D. C. electrical equipment which they have ever built has been constructed by Westinghouse for the purpose of operating the propeller testing unit. In addition to the above a complete water and sewage disposal system is being installed by various contractors. This latter includes a 200,000 gallon water tank which is located on an adjacent ridge.

The Administration Building

Facing in a somewhat westerly direction is the foremost building now on the field. It is three stories high and about two hundred feet long. This building is designed for use by the office force now employed at McCook Field and for the Field Service Section which is now located in cramped quarters at Wilbur Wright Field. A special feature of the Administration Building

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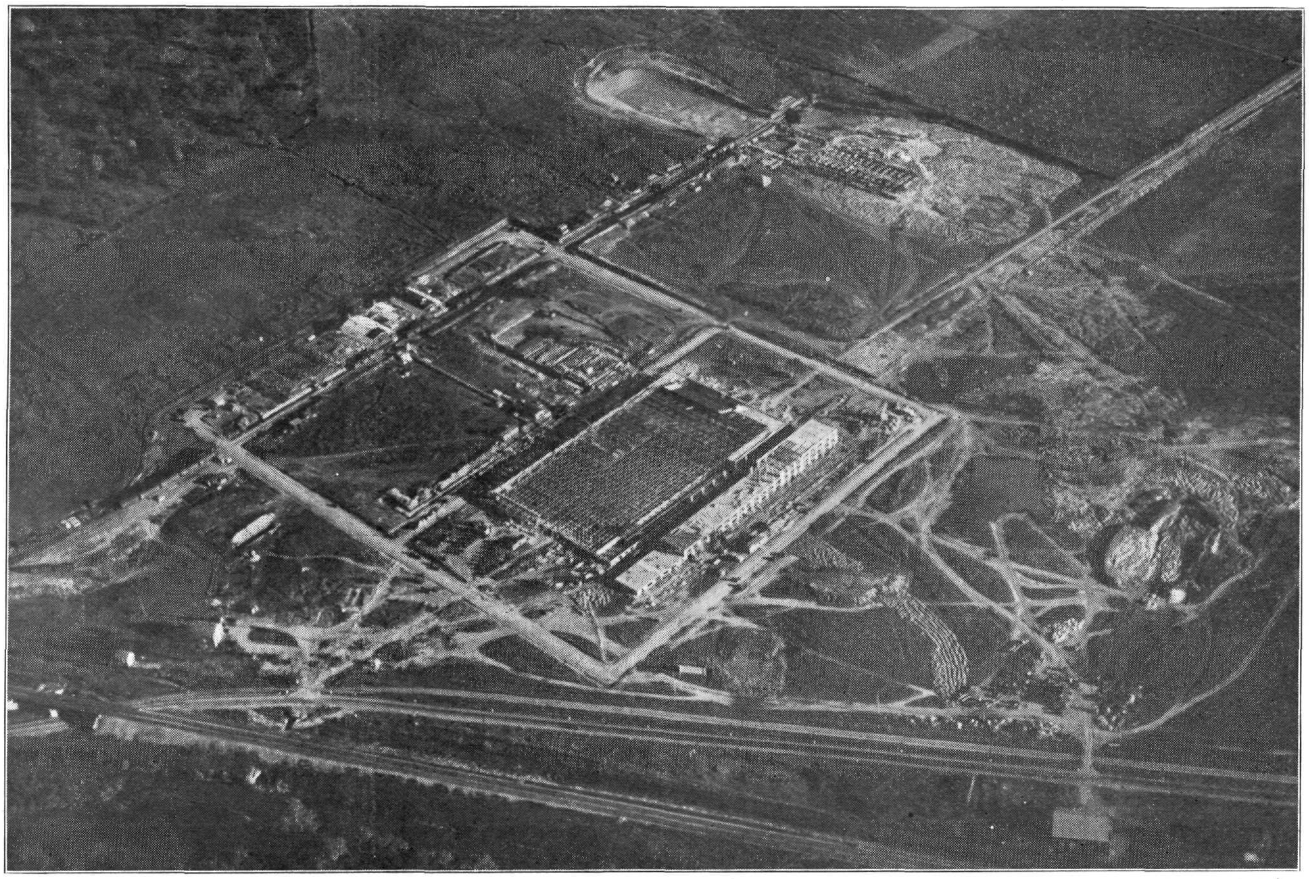

—*Courtesy U. S. Army, Q. M. C.*

Aerial photo showing the Administration Building, Testing Laboratory and Shops in the foreground. Excavations for the Wind Tunnels may be seen in the background.

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will be the Museum. It will be an extension upon the Museum already located at McCook field. In it will be found a complete history of the original Wright Airplane, including the original machine, original motor, plans, and development. In connection with this department of interest will be a small auditorium having a seating capacity of about five hundred. A moving picture machine will be installed which will be used to show experimental tests, stunts, results of experiments, and other aerial matters of interest.

The Propeller Testing Laboratory

The prime purpose of this laboratory is to insure all propellers against failure in flight. To do this it is necessary to run tests as follows:

1. On at least one propeller of every new design, no matter what material is used in the construction of the propeller.
2. On large numbers of propellers when designs suitable for new materials are being developed.
3. On large numbers of propellers during the development of propellers for special uses, such as controllable pitch and reversible pitch propellers.
4. On all propellers submitted by outside inventors.

In addition to the tests on propellers, the apparatus in this laboratory is to be used for the tests of miscellaneous equipment, such as blowers, flywheels, etc.

In laying out the equipment being installed at Wright Field, an effort has been made to provide equipment suitable to test any propeller during the next ten years. To meet this requirement, a careful consideration of present engines indicates that the following power and speed ranges may be expected: 6,000 h. p. at 300 r. p. m., the power required gradually decreasing with the increasing r. p. m. to a minimum of 1,500 h. p. at approximately 4,300 r. p. m. The high-power, low-speed rating will be necessary for tests of possible propellers designed to be driven by more than one engine through gearing. The lower-power, high speed, rating is necessitated by the extreme speeds at which propellers on high speed pursuit airplanes can be run when diving the airplane with the engine running at full throttle.

An investigaion of all possible methods of driving propellers over the required range of horsepower and speed showed that the most economical method was to use three A. C. synchronous motors. The first motor is to have a rating of 6,000 h. p. at any speed between 300 r. p. m. and 720 r. p. m.; the second to have a rating of 3,000 h. p. at any speed beween 720 r. p. m. and 1,800 r. p. m.; and the third to have a rating of 2,500 h. p. at 1,800 r. p. m. and a rating of 1,500 h. p. at 4,320 r. p. m.

The three testing motors are to be installed with their shafts on a common center line. This is being done in order that a blower may be mounted on any one of the motors in such a manner as to produce a blast of air on a propeller undergoing test, thereby simulating flying conditions as nearly as possible. Since it may be necessary to test propellers as large as forty feet in diameter, the center line of the motors is twenty-five feet above the ground level.

The 6,000 h. p. and the 1,500 h. p. motors are arranged for single operation only, but the 3,000 h. p. motor is arranged for double end operation, since it is located between the other two. In every case a propeller to be tested is attached to the end of a very heavy jackshaft which is driven by the motor through a weaker link in order to protect the motor from torsional vibration and from damage in case of the failure of the propeller being tested.

The thrust of the propellers being tested will be measured by means of a Kingsbury Thrust Bearing in connection with an Emery Hydraulic weighing system.

In order that observations of the action of the propellers may be made while running, underground rooms are to be provided. Through slots in the roofs of these chambers the propellers may be observed without danger. These rooms will also house the apparatus necessary for the proper control of the speed of the testing motors, and also for the measuring of the power applied to a propeller under any condition.

Since the power supply to the Material Division will be alernating current at 33,000 volts, 3-phase, 60 cycles, it is necessary to provide a means of supplying the testing motors with A. C., the frequency of which may be adjusted by the operator at will. To do this the power supply is transformed to 6,600 volts and is supplied to two constant-speed motor-generator sets each consisting of a 3,600 h. p., 6,600 volt, 3-phase, 60-cycle, 900 r. p. m. synchronous motor driving two 1,250 kw., 600 volt, D. C. generators.

Each of these constant speed motor-generator sets supplies direct current to an adjustable speed motor-generator set consisting of two 1,660 h. p., 600-volt, 360-720 r. p. m., D. C. motors driving an A. C. synchronous generator, 2,350 kw., 3500-6,600 volts, 25-72 cycles, 6-12 poles, 100 per cent power factor. The speed control of the adjustable speed D. C. motors driving the adjustable speed A. C. synchronous generators is obtained partly by armature voltage control and partly by field control.

The above four motor-generator sets, one two-unit 1,500 kw. motor-generator set, one two-unit 1,000 kw. motor-generator set, and one three-unit motor-generator set with all necessary exciters and switching equipment are located in a concrete and steel building approximately ninety-six feet wide and one hundred forty feet long.

All the testing motors are located in the open air approximately 300 feet from the building housing the motor-generator sets. Each testing motor will be enclosed in a tight-fitting sheet metal casing to protect it from the weather.

Suitable bomb proofing is provided at each testing motor so that broken parts of any propeller under test will be caught. The peripheral speed of some of the propellers under test will be about as high as the speed of an ordinary rifle bullet, so that considerable care has to be exercised to prevent flying pieces from endangering personnel or equipment.

Perhaps a better understanding of the damage which a broken propeller may do to the flimsy

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airplane structure may be had when it is realized that the centrifugal force on some types of propellers may go as high as two or three hundred thousand pounds.

Wind Tunnels

Provision is made in the field layout for three wind tunnels, two of which have already been built and the third which will be constructed whenever the funds are available. The wind tunnel furnishes a very valuable laboratory for the airplane designer in studying the flying characteristics of different types of aircraft by use of models.

When the designer has in mind the construction of a new type of airplane, a small model is built to exact scale, and placed in the wind tunnel where a stream of air is drawn past it. The forces on the model are then measured.

By means of these models tests it is possible to predict with a reasonable degree of assurance the flying characteristics of the airplane, such as the speed which it would be able to attain, the rate at which it would climb, and the maximum altitude to which it would be capable of going. It is also possible to tell whether the ship will fly steadily or will have a tendency to pitch or roll, and how readily it will respond to controls operated by the pilot. By this procedure, mistakes which would be very costly in a full sized airplane are corrected in the model at a very small fraction of the cost of what they would be in the full sized machine.

The type of wind tunnels used by the Material Division is similar to a large Venturi tube, the models being placed for test in the smallest portion of the tube where the velocities are the highest, and the large specially designed propellers being placed at the large end of the Venturi to draw the air out.

At the present time, the Material Division has two wind tunnels already constructed, and these will be installed at the new Field. One of these is a very small tunnel which is only 14 inches in diameter at the point where the tests are made. This tunnel, however, is built for very high speed, and small models may be tested in it at a speed of 500 miles per hour. The air is drawn through this small tunnel by a 36-blade propeller-type blower which is driven by a 200 h. p. Sprague dynamometer.

Considerable care has to be exercised in the working out of the exact shape of these wind tunnels, so that streams of air flowing through them will be free from whirls and will be perfectly steady in speed. If this were not done, the model tests would not faithfully reproduce the conditions of the full sized machine, and the tests would not serve the purpose for which they are intended.

The second wind tunnel is five feet in diameter and can be operated at a speed of 300 miles per hour. The air current through this tunnel is obtained by means of two 12-blade fans placed one behind the other and each of which rotate in opposite directions. The advantage in this tandem operation of the fans lies in the fact that the single fan would tend to set the air swirling in the direction of rotation of the fan, whereas the use of the second fan removes this swirl from the air and exhausts it from the tunnel in the desired direction.

Each of the two fans are driven by two Sprague dynamometers developing 250 h. p. each, so that all together 1,000 h. p. is available for operating this wind tunnel. Direct Current for operating these motors is furnished by a 1,500 kw. motor-generator set, the alternator of this set being of the synchronous type, so that its speed is very uniform and, consequently, the voltage of the direct current machine is very constant.

It is very fortunate that it is possible to operate this set from a large distributing system such as the Dayton Power and Light Company, since the frequency of this system is very constant due to the large number of synchronous machines tied up through this system.

Plans are under way for the third wind tunnel which will be ten feet in diameter at the test section and will permit the testing of much larger models than has been possible in the past.

The main features being installed in the new Wright Field have been described. Outside of these and its remarkable size the field is not a whole lot different from any other aviation field in the United States. All of the Engineering Division now located at McCook Field will be moved to this new location where that Division will continue its aeronautical experimenting and advancement.

Daytonians are proud of the fact that this wonderful Aeronautical Engineering activity is to be added to their host of other large industries. Rightfully should they be proud and they should be commended as being the city in the United States which has contributed the most toward the advancement of avtiation.